Enabling
ZERO WASTE

Millbank Primary School

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CONSTRUCTING
EXCELLENCE
IN WALES

Enabling Zero Waste: Millbank Primary School

Content

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Executive Summary

Enabling Zero Waste (EZW) is a Constructing Excellence in Wales (CEW) initiative which aims to establish if, and how, the construction industry can achieve the zero waste targets established in the Welsh Government's waste strategy Towards Zero Waste.

CEW is working in collaboration with the industry to provide a detailed insight into the achievability of zero waste at present, along with identifying any associated barriers to achieving the targets, and disseminating best practice, solutions and opportunities.

The part-demolition, refurbishment and new build of Millbank Primary School was a project undertaken by WRW on behalf of Cardiff City Council. WRW applied to take part in the Enabling Zero Waste initiative.

Findings from the project have shown that whilst the project achieved the Welsh Government's current target of more than 70% diversion of waste from landfill, zero waste to landfill was not possible. The experience from Millbank Primary School highlighted the following elements listed in order of impact, all of which contributed to the generation of waste beyond zero waste aspirations:

1. Unforeseens
2. Time
3. Design
4. Materials

The project has highlighted the benefits that Building Information Modelling (BIM) and early discussions with the design and client team can bring to identifying and realising opportunities for waste minimisation.

Further recommendations include that for contractors it is imperative that a member of the site team take ownership for the management of waste. In addition, it is crucial that the person responsible for producing waste forecasts makes regular contact with the site team to ensure that forecasts are achievable, reasonable and based on previous performance. The importance of segregation of waste at source is also clear along with focussing and discussing waste at all stages of a project.

Client recommendations to assisting in the zero waste agenda include that minimum and defined lead in times need to be established. This would be invaluable in achieving site efficiencies, improving communications and reducing waste. Recycled content and renewables targets currently set for projects are also suggested to be reviewed along with the development of a sustainable products list with full life cycle analysis.

As a direct result of WRW's involvement in the Enabling Zero Waste project, the company has now instigated zero waste practices for all future projects:

- Waste is now on the agenda at pre let meetings with all subcontractors and waste mitigation strategies and projected volumes agreed well in advance of work commencing.
- SMARTWaste is used as a live document throughout projects and regularly updated. This data is discussed at monthly project report meetings.
- More accurate waste data has been passed to the estimating team to apply more understanding to similar future tenders.
- Waste projections are more clearly communicated to site teams in an effort to encourage continual waste improvement throughout the project. Waste mitigation is also on the agenda on the project start up meetings to identify areas for waste reduction.

Forthcoming legislation will require changes to current industry practices, these are also highlighted within the report and as such further investigation needs to be undertaken to assess the capability of infrastructure currently available for dealing with wastes that will be banned from landfill and incineration.

1.0 About Enabling Zero Waste

Enabling Zero Waste (EZW) is a Constructing Excellence in Wales (CEW) initiative providing practical, positive and active intervention to establish if, and how, the construction industry can achieve the overarching strategy target for waste in Wales of zero waste to landfill, together with identifying associated barriers by working with live construction sites.

CEW is working in collaboration with the construction industry to offer practical assistance to construction projects and site teams to explore viable solutions to achieving zero waste. The project will provide a detailed insight into the achievability of zero waste to landfill at present.

Project objectives

- To understand and evidence when and how wastes occur during the construction process
- To understand current strategies, methodologies and opportunities for the landfill diversion of on-site wastes
- To analyse the feasibility/viability of achieving zero waste to landfill in the current environment
- To work to develop solutions to prevent and minimise the generation of on-site waste, generating a reduction in waste management, disposal and landfill costs
- To support changes to behaviour and processes that encourage prevention and minimisation of waste
- To achieve site efficiencies from waste management opportunities/solutions – reduction in deliveries, improved site traffic, reduction in supplies and material costs, operational productivity
- To disseminate the solutions and opportunities from the development of effective waste management strategies
- To provide learning and education opportunities regarding alternative waste management techniques which can be disseminated for future projects ensuring continual benefits

This report has been prepared after site completion to present the outcomes, opportunities and achievements of the project.

1.1 About WRW Construction Ltd

Founded by Managing Director Robert Williams MBE and Group Director Debbie Williams in 1985, WRW has grown organically and played an instrumental role in three decades worth of development in the education, commercial, civil, leisure, restoration and residential areas of the construction industry.

WRW focus on building on quality, providing progressive and integrated construction solutions that represent the very best value and exceptional quality, from fit-outs and redevelopments, to residential and turn-key solutions.

2.0 Millbank Primary School

Millbank Primary School was a project undertaken by WRW on behalf of Cardiff City Council. It involved the refurbishment of an old Victorian school building and a post war traditionally built extension, the demolition of a 1970's link and the construction of a new link. The original requirements of the project for the refurbishment of the existing buildings, became increasingly complex due to finding more dry rot and wet rot than anticipated. This issue led to the creation of more waste than was originally forecast and considerable changes to programme. The project was due for completion in time for the start of term in September 2014, however, due to the extent of the issues found on site, completion was delayed until January 2015.

The project had a recycled content target of 10%.

At the start of the EZW project the Millbank design had been finalised, necessary planning permissions were in place, contractor, tier one sub-contractors, suppliers and waste management contracts had all been appointed.

2.1 Cost

The initial value of the project was reported as £2.3million. Given the extent of the unforeseen issues, such as dry and wet rot, this escalated project costs.

2.2 Contract type

The scheme was a thirty week build contract. The design (excluding drainage) was supplied by Cardiff City Council. The project was procured as part of the 21st Century Schools programme.

3.0 Methodology

Every Enabling Zero Waste project participant was provided with a tailored work plan/methodology. The content was developed with the project team and designed to enhance any existing measures being undertaken.
For the duration of the build, the Millbank project team was provided with:

- Technical waste management support and guidance for the duration of the site construction to assist with the achievement of zero waste to landfill.
- A specific waste management resource allocated to provide hands on support with site waste management and to deliver potential zero waste options/solutions for site waste issues. This assistance included onsite visits and waste management support advising upon increased segregation, identification of materials used on site, reduction in waste by encouraging good housekeeping to reduce damage and over ordering of materials, and reduction of waste through reuse or finding alternative solutions to disposal.
- Assistance working with the site supply chain, clients and waste management companies to encourage take back schemes, wider education and increase waste data quality.
- Preparation, monitoring and update of a Site Waste Management Plan (SWMP) using BRE SMARTWaste.
- Preparation of a Building Information Model (BIM) of the site, developed from information supplied by Cardiff City Council.
- Review and optimisation of the design using the BIM to minimise waste, analyse and estimate the volume and type of waste arisings, and identify potential on site clashes.

In total seven waste management support site visits were undertaken as part of Enabling Zero Waste, which included discussions with the site team regarding current site and waste issues, progress, potential solutions and improvements. After every site visit, recommendations were issued to assist in improving waste management practices.
The principal waste management recommendations were to:

- Include waste as part of pre-let discussions to ensure that everyone is aware of their responsibilities and that a strong waste prevention ethos is created at the very start of a project and continued throughout.
- Reuse spoil and hardcore on site.
- Identify a waste champion to review and ensure that legal compliance and waste management best practices are met.
- Undertake toolbox talks to raise awareness with regard to waste prevention and reduction.
- Prevent the spoilage of materials on site by keeping them dry and kept in a secure place.
- Include the topic of waste within site inductions and site specific requirements.

Associated documentation and guidance regarding the above were also provided.

Building Information Modelling (BIM) was also carried out as part of the project to identify clash detections and to look at possible reductions in waste through hypothetical design changes or material changes. Aerial drones were also used to capture progress throughout the project.

Communications involved regular updates via twitter, events, webinars and presentations.

4.0 Key findings and outcomes

4.1 Analysis by construction phase

In summary 700m³ of waste was generated by the project.
Figure 1 illustrates the volume of waste by type produced throughout the project.

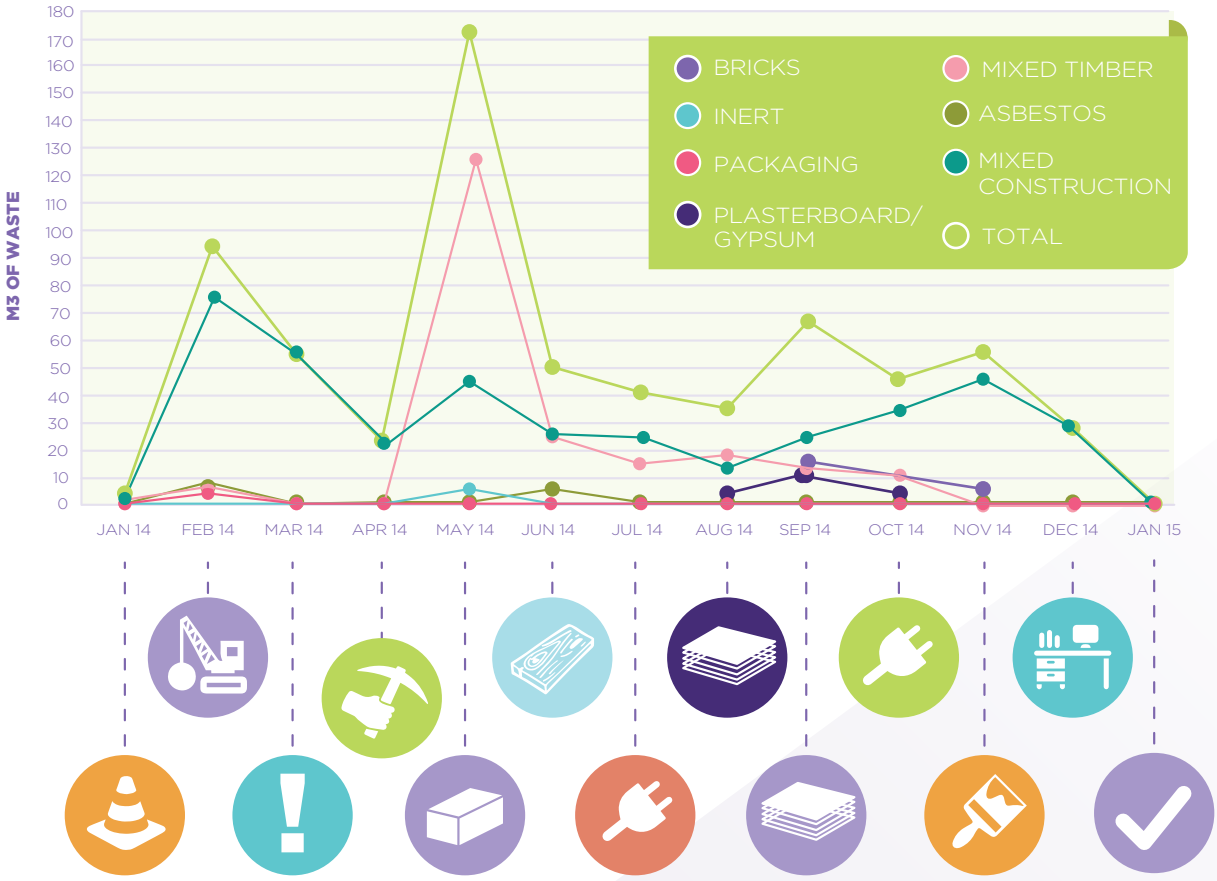


Figure 1: Millbank Primary School - Total waste by type throughout the project

4.1.1 Site set up

During this phase the majority of the waste produced related to site clearance activities and was reported as mixed approximately 4m³.

4.1.2 Demolition and site strip

The 1970s building was demolished by Bond Demolition prior to the scheme's inclusion in the Enabling Zero Waste project. No pre-demolition survey was undertaken but it is reported that an internal soft strip was carried out. Just over 37m³ of waste was produced as a result of the initial demolition work, the majority of this was inert material, predominantly bricks. Further brick waste arisings were created later in the programme when the Client requested the demolition of the external wall which was then rebuilt using new bricks. In total 24m³ of brick waste was created as a direct result of the demolition activity. The waste bricks were taken by Atlantic Waste to Neal Soil Supplies where they were crushed for reuse as recycled aggregate. Other waste streams produced as a result of the demolition work included mixed timber, asbestos (12.7m³) and mixed construction and demolition waste (43.8m³). Demolition waste was taken to Atlantic and Neals recycling for reprocessing.

4.1.3 Asbestos removal
In total, 12.7m^3 of asbestos was taken out of the building as part of the demolition phase. Additional asbestos was removed during the refurbishment and disposed of separately. Large asbestos sheeting was taken directly to a hazardous waste site in Swindon and insulation material was taken to a waste transfer station in Cardiff prior to appropriate disposal at a hazardous landfill site.

4.1.4 Refurbishment, wet and dry rot treatment, excavation work
Delays occurred on site as a result of the treatment of the wet and dry rot. Approximately 50m^3 of mixed construction waste was created from this activity.

4.1.5 Removal of plaster from the walls in existing structure
The resulting materials which by nature are composite and cannot practicably be separated inevitably were disposed of as mixed construction waste.

4.1.6 Wall construction and removal of timber floors
Timber floors were removed within the existing building. The predominant waste stream produced by this activity was contaminated mixed timber (over 160m^3) given the extensive dry and wet rot.

Approximately 60m^3 of mixed construction and demolition waste resulted from these activities together with small amounts of asbestos and inert material.

4.1.7 First fit mechanical and electrical
The majority of construction waste from this activity was of a mixed nature (26m^3). The mixed nature of this material is likely to have impacted upon recovery rates.

4.1.8 Drylining, ceilings, services, tiling, mechanical and electrical
Waste streams produced by these activities included mixed construction waste, mixed timber waste, plasterboard and brick waste.

4.1.9 Decoration, flooring, tiling, mechanical and electrical and carpentry
The majority of waste from these activities was reported as mixed construction waste approximately (80m^3), mixed timber (11m^3) and brick arisings (4m^3).

4.1.10 FFE and site clearance
As a result of the time pressures arising from the imminent handover deadline, all of the wastes derived from these activities were disposed of as mixed construction waste (approximately 30m^3).

4.1.11 Completion/Handover
The last waste collections in December were of a mixed nature. The site was handed over to the school in January 2015.

4.2 Analysis by programme
During the programme there were several distinct peaks of waste generation. The reasons for these peaks are detailed below.

4.2.1 February peak
In February the peak in waste consisted of mixed construction waste (77.45m^3) directly related to the demolition and site strip being carried out at that time. The lack of a pre-demolition survey precluded the creation of a clear plan for the reuse and segregation of material. The resultant demolition waste was comingled.

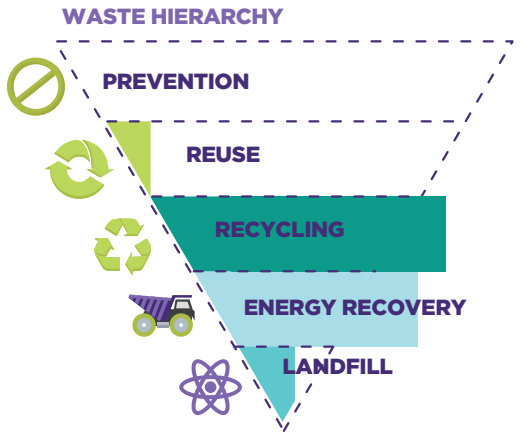
4.2.2 May peak
In May there was a significant peak in mixed timber waste (124.75m^3). This corresponds with the removal of the wet and dry rot from the building. This material had to be removed and could not be reused or recycled. The disposal of this waste to landfill was unavoidable.

4.2.3 September peak
The highest volume waste streams in September were mixed construction waste (25.7m^3), and bricks (16.2m^3) which arose from unplanned additional demolition works as instructed by the Client in September 2014 and November 2014.

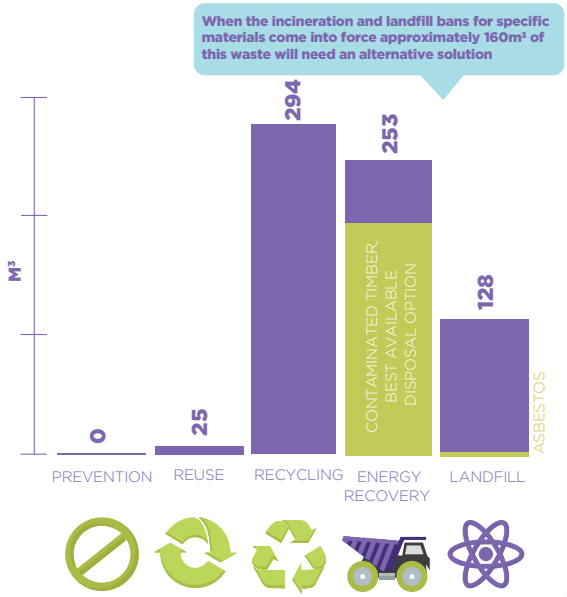
4.2.4 November and December peaks
A peak in mixed construction waste is shown in November (47.7m^3) and December (29.3m^3). From site visits undertaken during this period it is considered likely that this increase in mixed waste resulted from time pressures on site in order to realise project completion and to clear the site prior to handover. These factors may have contributed to a reduction in the on-site segregation of waste.

4.3 Analysis by waste management option

WASTE HIERARCHY (PROJECT ACTUALS)



ACTUAL WASTE ARISINGS (m^3)



To achieve zero waste, efforts need to be focused at the highest level of the waste hierarchy with waste prevention and minimisation. The diagram above provides a proportional representation of the waste arisings by waste management type.

4.3.1 Prevention

On this project the EZW project intervention did not directly prevent measurable quantities of waste. However, it should be noted that simple measures such as using off-cuts of materials on-site would have led to a reduction in the generation of waste arisings, although this reduction could not be readily quantified. The BIM exercise, detailed in section 5.1 remodelled the building design (within planning limitations) and identified the potential for 80m^3 of avoidable waste arisings (based on the 12.1% reduction of materials usage in the construction of the wall).

4.3.2 Reuse

Working with the supply chain, six skips of surplus and/ or damaged Durisol blocks were returned to Durisol for reuse. This equated to approximately 25m^3 of material which would have otherwise been sent to landfill.

4.3.3 Recycling

Forty-two percent (294m^3) of the waste produced during the project was recycled. The highest recycling rates for materials included a 100% recycling rate for cardboard, plasterboard and plastic. The recycling rate for inert waste was reported at 98% by the waste management company. The lowest recycling rates achieved resulted from the mixed waste which was reported at 60.3%. This is considered to result from the mixed nature of waste in the skips which may have led to cross contamination and therefore a lesser quality of recyclate.

4.3.4 Energy Recovery

Thirty–six percent (253m^3) of waste was sent for energy recovery. The majority of this waste relates to the high volume (209m^3) of contaminated timber for which incineration/energy recovery is currently the best available option.

4.3.4 Landfill

Eighteen percent of waste was sent to landfill (128m^3), the majority of which was of a mixed composition. Twelve cubic metres (12m^3) of the total waste sent to landfill was asbestos, the only economic option currently available. The relatively high landfill figure (18%) was to a large extent due to a fire at the waste management company which occurred during the reporting period. This fire severely affected the waste management company's operational efficiency and resulted in this level of waste being sent for landfill disposal.

4.4 Analysis by individual waste streams

4.4.1 Timber

The unexpected dry and wet rot present within the building presented the site team with several challenges. Firstly, more timber waste was produced at the site than anticipated. In addition, at the start of the project the site team had been anticipating leaving in situ the original wood parquet flooring and floor joists. However, given the wet and dry rot present this became impracticable. Timber joists and beams were repaired and reused throughout the old building as far as possible, however, these have not been quantified. Waste transfer notes did not split clean or dry rot wood and so we have estimated that the majority of this waste was sent for energy recovery, rather than chipped for animal bedding, which was the other specified end destination.

The project team had an initial target of ten timber skips and the actual number at the end of the project was reported as thirty three. The difference between target and actual being entirely due to the unforeseen extent of the dry and wet rot encountered.

4.4.2 Bricks

In total 24m^3 of brick waste was produced as a result of the requirement for the demolition of the old school wall. Brick waste was taken to Atlantic and Neal Soil supplies and crushed for reuse as aggregate.

4.4.3 Durisol blocks

The project used Durisol blocks in the construction of the new building. These blocks are manufactured from waste chipped wood bound together with cement. Once in situ they are bonded in place with polystyrene foam and cement based grout. The product was specified by the Client to help achieve the 10% recycled content target for the scheme, however, this has also flagged up potential future issues. Our observations of the adopted methodology for the use of the blocks on this project lead us to conclude that the only disposal route at end of life would be landfill. By incorporating steel reinforcement, polystyrene and cement grout as infill and the use of expanded foam to fill voids would make separation of these materials from the block highly impracticable. A take back arrangement was agreed with Durisol that they would accept any unused blocks back into their stock and any broken blocks would go back into the manufacturing process to be reused to make wall forms. This agreement ensured that any surplus or broken Durisol blocks were diverted from landfill which resulted in cost savings of £360.

4.4.4 Plasterboard

More plasterboard waste was produced (18.3m^3) than originally anticipated (8m^3). The original work was to repair and skim over the existing plaster, but once the dry rot was found, the plaster had to be removed in order to remove the wood that was embedded within the brickwork. 18.3m^3 of plasterboard waste was produced of which 100% is understood to have been recycled.

4.4.5 Asbestos

Asbestos was found during the demolition and refurbishment of the building. 12.7m^3 of this waste was sent to a hazardous landfill facility. Landfill is considered to be the most economic option currently available.

4.4.6 Mixed construction waste

The majority of skips that left the site were classified as mixed general waste and the project team failed to meet their anticipated target of 35 skips. At the end of the project 102 mixed waste general skips had left the site. The difference between the anticipated and actual targets is considered to result from a number of factors. At the start of the project the site had in place segregated skips for inert, timber and mixed waste. However, as the project progressed, deadlines grew closer and changes to site staff were made it was found that the skips were being contaminated. This consequently led to waste being disposed of as mixed waste at a higher cost.

By the end of the project there were also large quantities of cardboard waste produced which were also placed in the general mixed waste skip rather than a segregated skip. Consequently the cost of removal was higher than it should have been.

Mixed construction waste was sent to Atlantic for processing and sorting. During the reporting period in question it is understood that approximately 60% of this waste was recycled, 11% was sent for incineration with the remaining 29% sent for landfill disposal. The landfill disposal rate for the waste management company was much higher than its normal rate due to the impact of a serious fire in 2014 which negatively affected the efficiency of the recovery facility. The recycling rate for the mixed construction waste may have also resulted from the mixed nature of the material which is likely to have become contaminated and therefore of a less high quality recyclate.

4.5 Analysis by cost

Total waste disposal costs for the project were £21,340. Savings from the Durisol block take-back agreement totalled £360. The overall cost of waste disposal would have been reduced if fewer skips had been categorised as "mixed waste". Mixed waste skips are traditionally charged at a higher rate than single waste skips and greater segregation of waste at source could have resulted in considerable savings. For example, if WRWs mixed waste skip target of 35 skips in comparison to their actual of 102 had been achieved and the remainder had been at a segregated price of a skip savings of £1,340 would have been made. The actual waste disposal costs for the Millbank scheme represent only 0.7% of the capital value of the scheme. Nevertheless, in monetary terms the £20,000 cost of waste is a considerable sum which potentially could have been reduced. For construction companies involved in multiple schemes each year there are opportunities to achieve considerable annual monetary savings.

4.6 Analysis against industry benchmarks

Waste arisings at Millbank were compared against average m^3 of waste arisings for other projects based on both footprint and capital costs.

Millbank Waste	SMARTWaste data for Wales (Education new build)	SMARTWaste data for Wales (Education refurbishment)	BREEAM Credits (Amount of waste generated per $100m^2$ gross internal floor area)	
$52.8m^3/m^2$	$17.5m^3/m^2$ based on 30 projects	$22.3m^3/100m^2$ based on 5 projects	1 credit $<13.3m^3$	3 credits $<3.4m^3$
$30.4m^3$/£100k	$10.3m^3$/£100k based on 31 projects	$12.9m^3$/£100k based on 6 projects	2 credits $<7.5m^3$	Exemplary $<1.6m^3$

CEW obtained data from BRE's SMARTWaste system on construction waste arisings for projects carried out in Wales that had been completed by the end of June 2013. SMARTWaste is an online reporting system that can help track, manage and report on environmental impacts and sustainability including waste management.

BREEAM (BRE Environmental Assessment Method) is a widely used environmental assessment method for buildings and communities. It addresses environmental and sustainability issues and credits are used as part of the assessment criteria.

The extensive and unforeseen quantities of both dry and wet rot timber are considered to be the most likely factor in the overall achievement shown from Millbank.

5.0 Building Information Modelling (BIM)

As part of Enabling Zero Waste Gillard Associates Ltd were commissioned to prepare a BIM model to inform and educate participants on the subject of waste management, either by helping with onsite decision making, or by looking at virtual scenarios post construction. Since the Millbank School scheme was adversely affected by unforeseen defects in the existing school's fabric, the project programme became very compressed. This was a significant limiting factor which prevented the BIM model being used or interrogated during the construction period. Consequently the use of BIM was focused on virtual and hypothetical outcomes post completion.

5.1 Process improvement

It is widely recognised in the built environment sector that the translation of two dimensional drawings into the actual three dimensional structure frequently gives rise to unforeseen clashes. Particularly in respect of complex junctions and mechanical and electrical services. As is common practice the clashes encountered at Millbank were resolved reactively on site, often negatively impacting material and time resources.

At the post contract project review, it was clear that clash problems identified by the BIM team were (excepting the defective existing building structure) the main causes of difficulty during the build. Whilst it is easy to see benefits in hindsight, it is also true to say that the BIM model could have made a valuable contribution to the detailed design process by allowing virtual investigation of issues which were identified in the previous report.

A BIM workshop was carried out with the site team and Client to look at hypothetical changes to the design of the building and materials used. This led to an investigation into the outcomes of an alternative design for the new school extension and comparison with the actual design. The rationale behind this was to achieve better energy performance by reducing the external envelope of the building (closing the exposed areas between the proposed extension and the existing building).

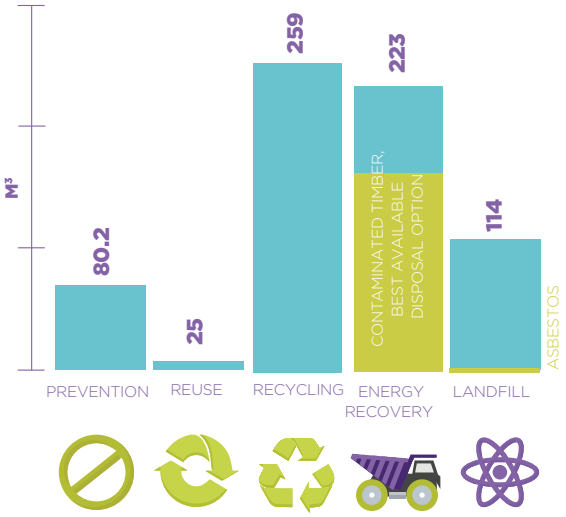
During the BIM workshop it was noted that the kitchen size was considered excessive for the type of school. Its overall size was reduced by 20%.

Energy performance was also looked at by reducing the external envelope of the building (closing the exposed areas between the proposed extensive and existing building). This would have led to a reduction of 13.06% in CO_2 emissions as a result of these changes. In addition the construction wall volume would have reduced from 328.11m^3 (actual) to 287.89m^3 a reduction of 12.1% which would have led to resource savings. The roof, floor and glazed areas, however, would have increased by between 0.8-5.8%.

As built model

Alternative design model

WASTE ARISINGS (m^3) WITH APPLICATION OF BIM EXERCISE



6.0 Future proofing - Application of Environment Bill

The project has highlighted the potential for future waste issues for the industry. The upcoming incineration and landfill bans for wood, paper, cardboard, glass, plastic, metal and food waste as part of the Environment Bill, when applied to the waste arisings from Millbank Primary School approximately 160m^3 of material the majority of which comprised mixed waste including paper and cardboard packaging and inert waste that was sent for energy recovery and landfill would need an alternative solution. As such, research will need to be carried out to understand what alternative disposal options and appropriate infrastructure are necessary to enable the changes required by legislation.

7.0 Key challenges

7.1 Unforeseens

Once the project had started it was identified that the existing building contained dry and wet rot which had not been identified prior to work starting. This resulted in additional waste being created through the removal of the contaminated timber but also through the removal of the associated plaster, flooring and ceilings.

7.2 Time

Time challenges on-site were presented to the site team as a result of using new products and the tight programme. As such, this may have resulted in the site team not being able to give as much focus to waste management practices as normal.

7.3 Products

Whilst the Durisol blocks were specified as a result of their high recycled content our conclusions stated in 4.4.3 leads us to conclude that the use of the blocks as permanent formwork on future schemes should give consideration to the adopted method of construction. Failing to consider these factors has the potential to give rise to disposal problems at the point of deconstruction.

7.4 Data

The pre-contract condition survey was undertaken during the school term so the presence of staff and pupils severely restricted access to all areas of the building. The consequent limitations of the survey resulted in a number of unforeseen issues, such as the dry and wet rot, only coming to light once construction was under way. The impact on the construction programme, on the waste generated and on the overall cost of the project was extremely significant.

The fire at the waste management facility also significantly impacted on the recovered waste from the contract. Historically the waste management facility's landfill diversion rate was greater than 90%. However, the fire seriously damaged the materials recycling facility (MRF) and seriously impaired the company's ability to recycle. The outcomes are reflected in the figures shown.

7.5 Behaviour

The changes in staff and management on site undoubtedly gave rise to inconsistencies with regard to waste practices. In addition, the agency staff appointed on the project presented challenges with regard to establishing buy in to the Enabling Zero Waste initiative and WRW's own practices.

The constrained site, challenging logistics and project timescales resulted in waste management practices becoming a secondary thought. A lack of BREEAM requirement and incentive to minimise waste, meant there was a lack of waste awareness and focus on site through limited discussions during pre-lets, site inductions, and clear skip signage. Waste was not focused upon as strongly as it could have been during site inductions or pre-let meetings and the contamination of segregated skips resulted in a higher number of mixed waste skips being produced.

8.0 Successes

8.1 Surplus

Surplus materials such as paint, floor tiles and windows were left within a storage area for the school to be able to carry out touch up and repairs when required.

8.2 Site practices

Planning and preparation for the segregation of waste had been undertaken, site waste management at the start of the project was effective.

8.3 Supply chain

A take back arrangement was made with Durisol that they would accept any unused blocks back into their stock and any broken blocks would go back into the manufacturing process to be reused to make wall forms. This agreement ensured that any surplus or broken Durisol blocks were prevented from being disposed of at landfill and savings of £360 were made.

8.4 Community engagement

WRW worked closely with the school and local community to involve and inform them regarding the environmental impact of construction.

8.5 Welsh Government Targets

The project has met the 2015/16 Welsh Government target for a minimum of 70% of all waste to be prepared for reuse, recycled or recovered.

8.6 Post project follow up

As a direct result of WRW's involvement in Enabling Zero Waste, the company has now instigated the following changes for all future projects:

1. Waste is now on the agenda at pre let meetings with all subcontractors and waste mitigation strategies and projected volumes are agreed well in advance of work commencing.
2. SMARTWaste is used as a live document throughout projects and regularly updated. Previously this may not have always been the case with much of the evidence collection done in a batch at project completion. This data is discussed at monthly project report meetings.
3. More accurate waste data (number of skips, amount of segregation achieved, etc) has been passed to the estimating team to apply more understanding to similar future tenders.
4. Waste projections are more clearly communicated to site teams in an effort to encourage continual waste improvement throughout the project. Waste mitigation is an agenda on the project start up meetings to identify areas for waste reduction.

9.0 Conclusion and recommendations

9.1 Conclusion

The WRW team are to be commended for their open and frank participation in Enabling Zero Waste. Aspects of the project were not without challenge and these were openly shared by the management and site teams.

Zero waste to landfill was not possible for this project, however, the real value in Enabling Zero Waste was to gain a greater understanding of the intricacies of the construction processes, their interrelationships and the impact upon waste arisings.

The learned experience from Millbank school highlighted the following elements listed in order of impact, all of which contributed to the generation of waste beyond zero waste aspirations:

1. Unforeseens
2. Time
3. Design
4. Materials

As the project developed a series of unforeseen challenges arose which in the case of the dry and wet rot led to approximately 200m^3 of contaminated timber being produced which was not planned for. This equated to nearly 30% of total waste arisings. In addition, more plasterboard waste was produced than originally anticipated as the original work was to repair and skim over the existing plaster. Once the dry rot was found, the plaster had to be removed in order to remove the wood that was embedded within the brickwork. Whilst the unforeseens impacted upon waste forecasts, arisings and management it also significantly lengthened the programme of the project.

The contract was originally let on a very short programme from January 2014 to September 2014. The time pressures that site teams have to work under often unfortunately force the issue of waste to the bottom of the daily priority list. In Millbank's case this time pressure is likely to have been a contributing factor in terms of the predominantly comingled nature of the waste disposed of from site. The time based programme is seen to be a critical factor to achieving quality outcomes.

Design can have a significant impact on waste arisings. In Millbank's case, the design of the building is considered likely to have increased the amount of waste produced and materials used. As discussed in this report, by using BIM to reduce the external envelope of the building, material and associated waste resource savings could have been achieved. In addition, if the unforeseens had not occurred, more time would have been available to the site team to use the BIM model fully during construction, enabling clash detections to be resolved before they occurred on site, and again saving resources and time.

The use of sustainable products does not always take into consideration disposal and associated end of life issues. In some cases, methods employed to satisfy these requirements can have knock on negative impacts or have not been utilised to their fullest degree.

9.2 Contractor recommendations

It is imperative that the person responsible for producing the waste forecast makes regular contact with the site team to ensure that forecasts are reasonable, achievable and based on data from past performances. It is also of importance for this person to share best practice and provide feedback on performance. Fundamentally a member of the site team must take ownership for the management of waste.

Company procedures should be refined with regard to forecasting project waste, the collection and storage of waste data, the management of site waste and reporting requirements. Internal audits of company activities should also take place at regular intervals to ensure that procedures and processes are working.

Segregation at source is vitally important to the increase of recovery rates for waste arisings. The most advanced waste management company will struggle to achieve recovery rates of over 90% (as required by 2019/20) for comingled waste. This will also become an increasing issue with the introduction of the Environment (Wales) Bill which will require waste producers to source segregate paper, cardboard, glass, metal, plastic, wood and food

wastes. These and other waste requirements must be discussed during pre-let and pre-construction meetings to ensure that everyone understands their responsibilities and that waste is highlighted as a priority. Waste requirements and reporting mechanisms should also be agreed with the chosen waste management company to ensure that they are aware of the project reporting needs and to discuss opportunities for the management of waste.

During site inductions waste should be focussed upon so that all staff members are aware of what they need to do with regard to on site waste management. In order to enable this tool box talks should be developed and undertaken with all members of the site team. Awareness raising with all company staff should be undertaken to outline the importance of addressing waste issues and associated costs.

Building Information Modelling (BIM) has the potential for significant benefits and could be used to help identify clash detections, identify opportunities for waste minimisation (by using standardised dimensions for bricks, blocks and plasterboard), streamline the construction process and ensure that any issues are resolved prior to work on site taking place.

Early discussions should take place with the design team and/or client to ascertain whether the scheme has been designed to standard dimensions to design out waste and if not, whether there is opportunity to do so highlighting time, resource and cost benefits. Prior to agreements taking place with suppliers, the possibility of take back schemes for surplus materials, packaging, off-cuts and damaged goods should be discussed and agreed.

If demolition work is to take place, a pre-demolition survey should be undertaken to identify opportunities for reuse and recycling.

9.3 Recommendations to Client

The use of sustainable products does not always take into consideration disposal and associated end of life issues. The development of a sustainable products list with full life cycle analysis should be developed to ensure that future issues associated with products are addressed.

Time decisions and programming can have a significant influence on a project. Minimum lead in times should be established to allow time for contractors to mobilise once a tender has been awarded. Establishing defined lead in times enables all site, design and client teams to get together at an early stage to discuss the project. These meetings can be invaluable in reducing waste, improving communications and developing site efficiencies. Recycled content targets currently set for projects need to be reviewed in order to ascertain whether this is the most appropriate way to heighten the sustainability of a scheme. In some cases, methods employed to satisfy these requirements can have knock on negative impacts or have not been utilised to their fullest degree.

Investigation needs to be undertaken to assess infrastructure currently available for dealing with wastes that will be affected by the upcoming landfill and incineration bans. If solutions are not available these will need to be addressed.

Some key findings from the initiative and from other experience is that projects can achieve extremely high recycling and recovery rates (achieving Welsh Government's industry targets) but this can often be due solely to the efficiencies of the waste management company being used rather than any on site practices. When monitoring and managing waste as part of a project we need to focus more on how much waste was produced and prevented rather than how much was diverted from landfill.

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Galluogi

DYFODOL DIWASTRAFF

Ysgol Gynradd Millbank

Noddir gan Lywodraeth Cymru
Sponsored by Welsh Government

ADEILADU ARBENIGRWYDD YNG NGHYMRU
CONSTRUCTING EXCELLENCE IN WALES

Galluogi Dyfodol Diwastraff: Ysgol Gynradd Millbank

Cynnwys

Trosolwg

Galluogi Dyfodol Diwastraff: Ysgol Gynradd Millbank

Trosolwg

Rhaglen gan Adeiladu Arbenigrwydd yng Nghymru (CEW) yw Galluogi Dyfodol Diwastraff (Enabling Zero Waste -EZW). Y nod yw sefydlu os, a sut, y gall y diwydiant adeiladu yng Nghymru gyrraedd y targedau diwastraff yn strategaeth wastraff Llywodraeth Cymru, Tuag at Ddyfodol Diwastraff.

Mae CEW yn cydweithio â'r diwydiant adeiladu i gasglu gwybodaeth fanwl am ymarferoldeb y targed "dim gwastraff" presennol. Mae'n ceisio adnabod y rhwystrau rhag cyrraedd y targed ac yn dosbarthu gwybodaeth am yr arferion, yr atebion a'r cyfleoedd gorau.

Cynllun dymchwel yn rhannol, adnewyddu ac adeiladu o'r newydd oedd prosiect Ysgol Gynradd Millbank, ac ar gyfer ei weithredu dewiswyd cwmni datblygu ac adeiladu WRW gan Gyngor Dinas Caerdydd. Roedd WRW yn awyddus i gymryd rhan yn y rhaglen Galluogi Dyfodol Diwastraff.

Llwyddodd y prosiect i gyrraedd targed presennol Llywodraeth Cymru o arbed 70% o wastraff rhag cael ei yrru i'w gladdu mewn safle tirlenwi, ond dangosodd hefyd nad oedd modd llwyddo i yrru dim gwastraff o gwbl i'w dirlenwi. Amlygodd profiad Ysgol Gynradd Millbank yr elfennau canlynol, a restrir yn nhrefn eu dylanwad – ffactorau a gyfrannodd tuag at fethu â gwireddu'r dyhead i gynhyrchu dim gwastraff o gwbl:

1. Pethau na ellid eu rhagweld
2. Amser
3. Dyluniad
4. Deunyddiau

Dangosodd y prosiect fanteision Modelu Gwybodaeth Adeiladu (Building Information Modeling -BIM) a'r modd y gall trafodaethau cynnar gyda'r tîm dylunio a'r cleient adnabod a gwireddu cyfleoedd ar gyfer lleihau gwastraff gymaint â phosibl.

Mae'r argymhellion pellach yn cynnwys y rheidrwydd i gontractwyr gael aelod o dîm y safle yn gyfrifol am y dasg o reoli gwastraff. Hefyd, mae'n allweddol bwysig fod y person sy'n gyfrifol am baratoi rhagolygon cynhyrchu gwastraff yn cysylltu'n rheolaidd â thîm y safle i wneud yn siŵr fod y rhagolygon yn gyraeddadwy, rhesymol a seiliedig ar berfformiad blaenorol. Mae'n glir hefyd fod angen didoli gwastraff yn ei ffynhonnell a chael ffocws ar, a thrafod, materion gwastraff trwy gydol bob cyfnod o'r prosiect.

Gwneir argymhellion ar gyfer cleientiaid er mwyn helpu'r agenda dim gwastraff. Mae'r rhain yn cynnwys yr angen i ddiffinio a sefydlu lleiafswm amser "arwain i mewn". Byddai hyn yn cyfrannu mewn ffordd allweddol ar safleoedd adeiladu tuag at sicrhau effeithlonrwydd, gwella cyfathrebu a lleihau gwastraff. Awgrymir hefyd y dylid adolygu'r targedau ailgylchu ac adnewyddu a osodwyd ar gyfer prosiectau ar hyn o bryd ynghyd â datblygu rhestr o gynhyrchion cynaliadwy gyda dadansoddiad o'u cylch bywyd llawn.

O ganlyniad uniongyrchol i ymwneud WRW â'r prosiect Galluogi Dyfodol Diwastraff, mae'r cwmni bellach wedi cyflwyno arferion "dim gwastraff" ar gyfer pob un o'u prosiectau yn y dyfodol:

- Mae gwastraff bellach ar agenda'r cyfarfodydd cyn-gosod a gynhelir gyda phob is-gontractwr. Cytunir ar strategaethau lleihau gwastraff a chytunir meintiau disgwyliedig ymhell cyn dechrau'r gwaith.
- Defnyddir SMARTWaste fel dogfen fyw trwy gydol prosiectau gan ddiweddaru'r wybodaeth yn rheolaidd. Defnyddir y data mewn cyfarfodydd prosiect misol.
- Gyrrwyd data gwastraff cywirach at y tîm amcangyfrif er mwyn datblygu gwell dealltwriaeth ar gyfer tendrau tebyg yn y dyfodol.
- Caiff amcangyfrifon gwastraff eu cyfathrebu'n gliriach i dimau safle mewn ymgais i annog rheoli gwastraff yn barhaus trwy gydol y prosiect. Mae lleihau gwastraff hefyd ar agenda cyfarfodydd dechrau'r prosiect er mwyn adnabod meysydd lle gellir gostwng y gwastraff a gynhyrchir.

Oherwydd deddfwriaeth arfaethedig, bydd raid newid arferion presennol y diwydiant. Nodir y newidiadau hyn hefyd yn yr adroddiad ac, i'r perwyl hwn, mae angen ymchwil pellach i asesu gallu'r seilwaith (infrastructure) presennol ar gyfer delio â gwastraff y gwaherddir ei dirlenwi a'i losgi.

1.0 Beth yw Galluogi Dyfodol Diwastraff?

Rhaglen gan Adeiladu Arbenigrwydd yng Nghymru (CEW) yw Galluogi Dyfodol Diwastraff (Enabling Zero Waste -EZW). Y nod yw darparu mewnbwn ymarferol, positif a rhagweithiol i sefydlu os, a sut, y gall y diwydiant adeiladu gyrraedd y targed ar gyfer gwastraff yng Nghymru lle na chynhyrchir unrhyw wastraff o gwbl. Mae hefyd yn ceisio adnabod y rhwystrau rhag cyflawni'r nod hwnnw trwy weithio law yn llaw â safleoedd adeiladu byw.

Mae CEW yn cydweithio â'r diwydiant adeiladu gan gynnig cymorth ymarferol i dimau prosiect a safleoedd adeiladu er mwyn archwilio dewisiadau ymarferol tuag at ddyfodol diwastraff. Bydd y prosiect yn rhoi darlun manwl inni o ba mor ymarferol yw'r nod o yrru dim gwastraff o gwbl i safleoedd tirlenwi.

Amcanion y prosiect

- To understand and evidence when and how wastes occur during the construction process
- Deall a darparu tystiolaeth ynghylch y modd y mae gwastraff yn cael ei gynhyrchu yn ystod y broses adeiladu
- Deall y strategaethau, dulliau a chyfleoedd presennol i arbed gwastraff safleoedd adeiladu rhag cael ei yrru i'w dirlenwi
- Dadansoddi ymarferoldeb gyrru dim gwastraff o gwbl i'w dirlenwi yn yr hinsawdd bresennol
- Gweithio tuag at ddatblygu atebion a fydd yn atal a lleihau i'r eithaf y gwastraff a gynhyrchir ar safleoedd adeiladu, gan ostwng costau rheoli, gwaredu a thirlenwi
- Cefnogi newidiadau mewn ymddygiad a phrosesau a fydd yn hyrwyddo'r gwaith o atal a lleihau i'r eithaf y gwastraff a gynhyrchir
- Cael arbedion effeithlonrwydd ar safleoedd adeiladu trwy fanteisio ar gyfleoedd ac atebion rheoli gwastraff – lleihau costau cludo, gwella traffig safleoedd, lleihau cost cyflenwadau a deunyddiau, gwella cynhyrchedd
- Rhannu gwybodaeth am atebion a chyfleoedd sy'n deillio o ddatblygu strategaethau effeithiol ar gyfer rheoli gwastraff
- Darparu cyfleoedd dysgu ac addysgu mewn perthynas â thechnegau rheoli gwastraff y gellir eu lledaenu ar gyfer prosiectau'r dyfodol a thrwy hynny sicrhau manteision parhaus.

Paratowyd yr adroddiad hwn ar ôl cwblhau gwaith ar y safle er mwyn cyflwyno deilliannau, cyfleoedd a llwyddiannau'r prosiect.

1.1 Pwy yw WRW Construction Ltd?

Sefydlwyd WRW gan y Rheolwr Gyfarwyddwr Robert Williams MBE a'r Cyfarwyddwr Grŵp Debbie Williams yn 1985. Ers hynny tyfodd y cwmni mewn ffordd organig gan chwarae rhan allweddol dros dri deg mlynedd yn y diwydiant adeiladu yn y meysydd addysg, masnachol, sifil, hamdden, adfer a chodi tai preswyl. Mae ffocws WRW ar ansawdd ac ar ddarparu atebion blaengar ac integredig sy'n cynnig y gwerth gorau oll. Anelant at ansawdd rhagorol wrth gyflawni gwaith yn amrywio o ffitio i ailddatblygu, i adeiladau preswyl i atebion "troi'r goriad" (turn-key).

2.0 Ysgol Gynradd Millbank

Roedd ailwampio Ysgol Gynradd Millbank yn brosiect a gyflawnwyd gan WRW ar ran Cyngor Dinas Caerdydd. Golygai adnewyddu hen adeilad ysgol Fictorianaidd ac estyniad traddodiadol a godwyd wedi'r ail ryfel byd, dymchwel linc a godwyd yn y 1970au ac adeiladu linc newydd. Y gofyniad gwreiddiol oedd adnewyddu'r adeiladau presennol, ond cymhlethwyd y dasg yn gynyddol pan ganfuwyd llawer mwy o bydredd sych a phydredd gwlyb na'r hyn a ragwelwyd. Arweiniodd hyn at gynhyrchu llawer mwy o wastraff nag a ragwelwyd yn wreiddiol a llawer iawn o newidiadau i'r rhaglen wreiddiol. Roedd y cynllun i fod i gael ei gwblhau erbyn dechrau tymor mis Medi 2014 ond oherwydd maint y problemau a gafwyd ar y safle, ni chwblhawyd y gwaith tan Ionawr 2015.

Roedd gan y prosiect darged ailgylchu cynnwys o 10%.

Ar ddechrau'r prosiect Galluogi Dyfodol Diwastraff roedd dyluniad Millbank wedi ei gwblhau; pob caniatâd cynllunio angenrheidiol yn ei le a'r contractwr, yr is-gontractwyr haen un, y cyflenwyr a'r contractau rheoli gwastraff oll wedi eu penodi.

2.1 Cost

Adroddwyd mai £2.3miliwn oedd gwerth gwreiddiol y prosiect. Oherwydd y problemau pydredd sych a gwlyb na chafodd eu rhagweld, cynyddodd y gost yma.

2.2 Math o gytundeb

Roedd y cytundeb ar ffurf contract adeiladu tri deg wythnos. Darparwyd y dyluniad (ac eithrio'r gwaith draenio) gan Gyngor Dinas Caerdydd. Cafodd y prosiect ei gaffael fel rhan o'r rhaglen Ysgolion yr 21ain Ganrif.

3.0 Methodoleg

Ar gyfer pob cyfranofwyr y prosiect paratowyd cynllun gwaith a methodoleg benodol. Datblygwyd y cynnwys gyda thîm y prosiect gyda'r bwriad o ychwanegu at unrhyw fesurau a oedd eisoes yn cael eu gweithredu. Dros gyfnod y prosiect, darparwyd y canlynol i dîm prosiect Millbank:

- Cefnogaeth dechnegol ac arweiniad rheoli gwastraff trwy gydol y cyfnod adeiladu i gynorthwyo'r broses o anelu at anfon dim gwastraff i'w dirlenwi.
- Clustnodi adnodd penodol rheoli gwastraff i roi cymorth ymarferol ar y safle adeiladu a gwireddu'r opsiynau ar gyfer cynhyrchu dim gwastraff ynghyd ag atebion rheoli gwastraff posibl. Roedd y cymorth a roddwyd yn cynnwys ymweliadau â'r safle a chyngor ynghylch didoli mwy o wastraff, adnabod y deunyddiau ar y safle, lleihau gwastraff drwy annog arferion darbodus a fyddai'n lleihau achosion o ddifrodi a gor-archebu nwyddau ac yn lleihau gwastraff drwy ailddefnyddio neu ganfod atebion eraill posibl yn hytrach na gwaredu.
- Cymorth i weithio gyda chadwyn gyflenwi'r safle, cleientiaid a chwmnïau rheoli gwastraff i annog cynlluniau "cymryd yn ôl", addysgu ehangach a gwella ansawdd y data ynghylch gwastraff.
- Paratoi, monitro a diweddaru Cynllun Rheoli Gwastraff Safle (Site Waste Management Plan – SWMP) gan ddefnyddio BRE SMARTWaste.
- Paratoi Model Gwybodaeth Adeiladu (BIM) ar gyfer y safle gan ddefnyddio gwybodaeth a ddarparwyd gan Gyngor Dinas Caerdydd.
- Adolygu ac optimeiddio'r dyluniad gan ddefnyddio BIM i leihau gwastraff i'r eithaf, dadansoddi ac amcangyfrif y foliwm a'r math o wastraff disgwyliedig, ac adnabod gwrthdrawiadau posibl ar y safle.

Gwnaed cyfanswm o saith ymweliad i gefnogi rheoli gwastraff fel rhan o'r rhaglen Galluogi Dyfodol Diwastraff. Ynddynt cynhaliwyd trafodaethau gyda thimau safle ynglŷn â heriau cyfredol y safle a rheoli gwastraff, y cynnydd a wnaed, datrysiadau a gwelliannau posibl. Yn dilyn pob ymweliad safle, gwnaed argymhellion i wella'r arferion rheoli gwastraff. Y prif argymhellion rheoli gwastraff oedd:

- Cynnwys gwastraff o fewn y trafodaethau cyn-gosod er mwyn sicrhau fod pawb yn ymwybodol o'u cyfrifoldebau a chreu ethos gref o blaid atal gref ar ddechrau cyntaf y prosiect a thrwy gydol ei barhad.
- Ail ddefnyddio rwbel a deunydd caled ar y safle.
- Adnabod hyrwyddwr arbed gwastraff i adolygu prosesau, sicrhau cydymffurfio â'r gyfraith a dilyn yr arferion gorau wrth reoli gwastraff
- Cynnal "sgyrsiau bocs tŵls" i godi ymwybyddiaeth ynghylch atal a lleihau gwastraff.
- Atal deunyddiau rhag cael eu difrodi ar y safle drwy eu cadw'n sych ac mewn man diogel.
- Trafod y pwnc gwastraff mewn cyfarfodydd ymsefydlu (induction) ac mewn gofynion penodol i'r safle.

Darparwyd dogfennau a chanllawiau perthnasol i'r uchod yn ogystal.

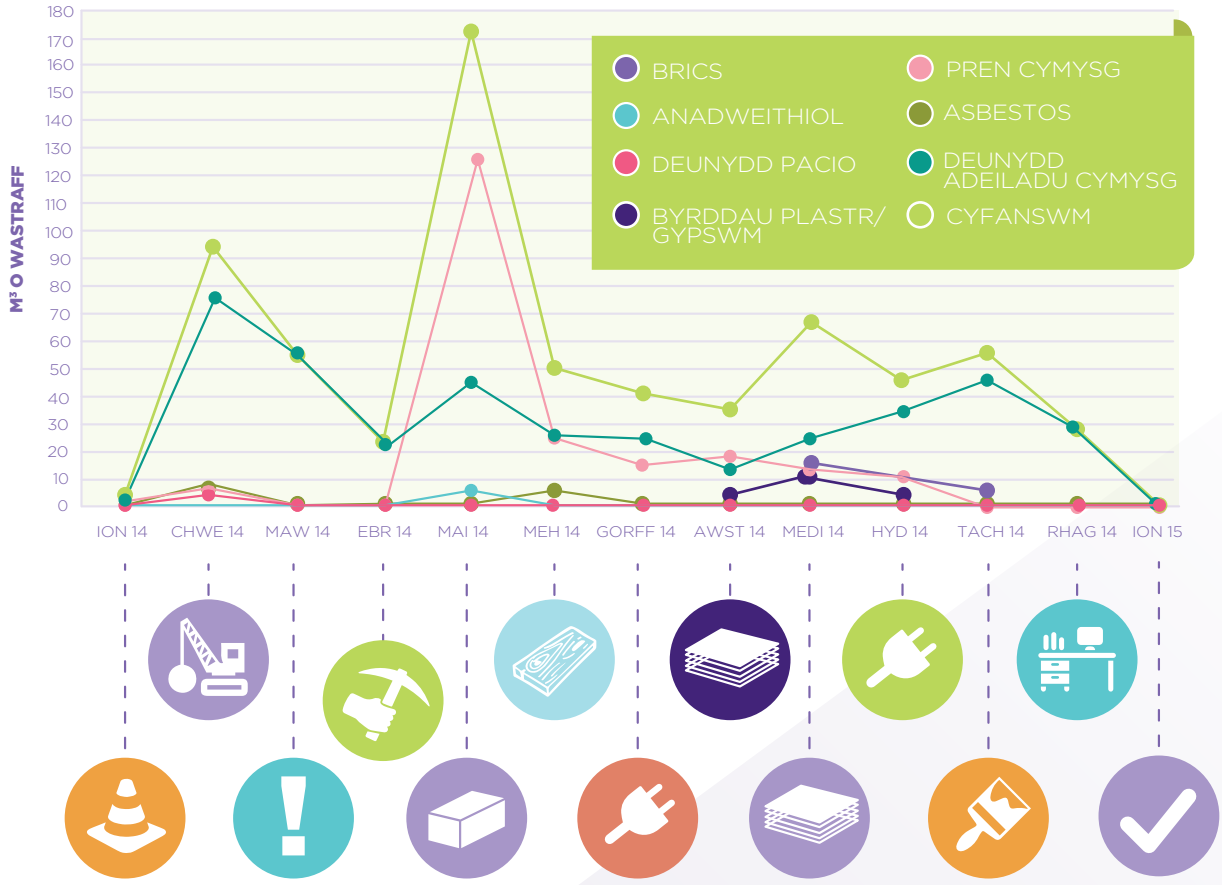
Defnyddiwyd y broses Modelu Gwybodaeth Adeiladu (BIM) hefyd fel rhan o'r prosiect er mwyn adnabod gwrthdrawiadau posibl ac ystyried ffyrdd posibl o leihau gwastraff drwy newidiadau damcaniaethol i'r dyluniad neu newid deunyddiau. Defnyddiwyd dronau awyr yn ogystal i dynnu lluniau o'r cynnydd a wnaed trwy gydol y prosiect.

Roedd y dulliau cyfathrebu yn cynnwys diweddariadau rheolaidd ar twitter, digwyddiadau, gwe-gyfarfodydd a chyflwyniadau.

4.0 Canfyddiadau a deilliannau allweddol

4.1 Dadansoddiad fesul cyfnod adeiladu

Cynhyrchwyd 700m³ o wastraff gan y prosiect.
Dengys Ffigwr 1 y foliwm o wastraff fesul math o wastraff a gynhyrchwyd trwy gydol oes y prosiect.



Ffigwr1: Ysgol Gynradd Millbank – Cyfanswm y gwahanol fathau o wastraff trwy gydol y prosiect

4.1.1 Cyfnod sefydlu'r safle

Yn ystod y cyfnod hwn, adroddwyd fod y rhan fwyaf o'r gwastraff a gynhyrchwyd yn wastraff cymysg - oddeutu 4m³.

4.1.2 Dymchwel a stripio'r safle

Cafodd yr adeilad a godwyd yn y 1970au ei ddymchwel gan Bond Demolition cyn i'r cynllun gael ei gynnwys yn y prosiect Galluogi Dyfodol Diwastraff. Ni chynhaliwyd unrhyw arolwg dymchwel ond adroddwyd y bu stripio meddal mewnol. Cynhyrchwyd ychydig dros 37m³ o wastraff o ganlyniad i'r gwaith dymchwel dechreuol. Roedd y rhan fwyaf ohono'n ddeunydd anadweithiol – brics yn bennaf. Cynhyrchwyd rhagor o wastraff brics yn ddiweddarach yn y rhaglen pan ofynnodd y cleient am ddymchwel y wal allanol a'i hailgodi gan ddefnyddio brics newydd. Cynhyrchwyd cyfanswm o 24m³ o wastraff brics yn uniongyrchol gan y gwaith dymchwel. Aed â'r gwastraff brics gan Atlantic Waste i Neal Soil Supplies lle cawsant eu malurio'n fân i'w hailgylchu fel agreg. Ymhlith y ffrydiau gwastraff eraill a gynhyrchwyd roedd coed cymysg, asbestos (12.7m³) a gwastraff cymysg adeiladu a dymchwel (43.8m³). Cludwyd y gwastraff dymchwel at gyfleusterau ailgylchu Atlantic a Neals i'w ailbrosesu.

4.1.3 Cael gwared o asbestos
Cymerwyd cyfanswm o 12.7m^3 o asbestos o'r adeilad yn ystod y cyfnod dymchwel. Yna symudwyd ymaith ragor o asbestos yn y cyfnod adnewyddu a chael gwared ohono ar wahân. Aed â shitiau asbestos mawr yn uniongyrchol i safle gwastraff peryglus yn Swindon a chymerwyd gwastraff insiwleiddio i orsaf trosglwyddo gwastraff yng Nghaerdydd cyn ei waredu'n briodol mewn safle tirlenwi deunyddiau peryglus.

4.1.4 Adnewyddu, trin pydredd gwlyb a sych, gwaith cloddio
Bu oedi ar y safle oherwydd yr angen i drin pydredd gwlyb a sych. Crëwyd tua 50m^3 o wastraff adeiladu cymysg gan y gweithgaredd hwn.

4.1.5 Tynnu plastr oddi ar waliau'r hen adeilad
Mae'r deunyddiau a gynhyrchir gan y broses hon yn anochel yn gymysg ac nid yw'n ymarferol eu gwahanu. Yn anochel felly, fe'u gwaredwyd fel gwastraff adeiladu cymysg.

4.1.6 Adeiladu waliau a chael gwared o loriau coed
Tynnwyd lloriau coed o'r hen adeilad. Y prif ffrwd gwastraff a grëwyd oedd coed cymysg halogedig (dros 160m^3) gan fod cymaint o bydredd sych a gwlyb. Crëwyd tua 60m^3 o wastraff cymysg adeiladu a dymchwel gan y gweithgareddau hyn, ynghyd ag ychydig asbestos a deunydd anadweithiol.

4.1.7 Ffitiadau cyntaf mecanyddol ac thrydanol
Roedd mwyafrif y gwastraff adeiladu a gynhyrchwyd gan y gweithgaredd hwn o natur cymysg (26m^3). Oherwydd natur gymysg y deunydd hwn, mae'r gwaith yma'n debygol o fod wedi dylanwadu ar y graddfeydd adfer.

4.1.8 Leinio sych, nenfydau, gwasanaethau, teils, gwaith mecanyddol a thrydanol
Roedd y ffrydiau gwastraff a gynhyrchwyd gan y gweithgareddau hyn yn cynnwys gwastraff adeiladu cymysg, gwastraff coed cymysg, byrddau plastr a gwastraff brics.

4.1.9 Addurno, lloriau, teils, gwaith mecanyddol, trydanol a gwaith coed
Adroddwyd mai'r gwastraff pennaf a gynhyrchwyd gan y gweithgareddau hyn oedd gwastraff adeiladu cymysgu (tua 80m^3), coed cymysg (tua 11m^3) a brics (tua 4m^3).

4.1.10 Dodrefn, Ffitiadau ac Offer (FFE) a chlirio'r safle
Oherwydd y pwysau amser wrth i'r amser trosglwyddo nesáu, cafwyd gwared o'r rhan fwyaf o'r gwastraff a gynhyrchwyd gan y gweithgareddau hyn fel gwastraff adeiladu cymysg (tua 30m^3).

4.1.11 Cwblhau / Trosglwyddo
Roedd y casgliadau gwastraff olaf yn Rhagfyr yn wastraff cymysg. Trosglwyddwyd y safle i'r ysgol yn Ionawr 2015.

4.2 Dadansoddiad fesul rhaglen
Yn ystod y rhaglen roedd sawl cyfnod gwahanol pan oedd y gwastraff a gynhyrchwyd ar ei uchaf. Nodir y rhesymau dros y cyfnodau hyn isod.

4.2.1 Anterth Chwefror
Yn Chwefror, roedd y gwastraff adeiladu cymysg a gynhyrchwyd (77.45m^3) yn deillio'n uniongyrchol o'r gwaith dymchwel a stripio safle oedd yn digwydd bryd hynny. Golygodd y methiant i gynnal arolwg cyn dymchwel na luniwyd cynllun clir ar gyfer ailddefnyddio a didoli a gwahanu deunyddiau. O ganlyniad roedd y gwastraff dymchwel oll wedi ei gydgymysgu.

4.2.2 Anterth Mai
Ym Mai gwelwyd uchafbwynt arwyddocaol yn y gwastraff coed a gynhyrchwyd (124.75m^3). Digwyddodd hyn yr un pryd ag y gwaredwyd pydredd gwlyb a sych o'r adeilad. Roedd yn rhaid symud ymaith y deunydd hwnnw ac ni ellid ei ailddefnyddio na'i ailgylchu. Yn anochel, felly, rhaid oedd ei anfon i'w dirlenwi.

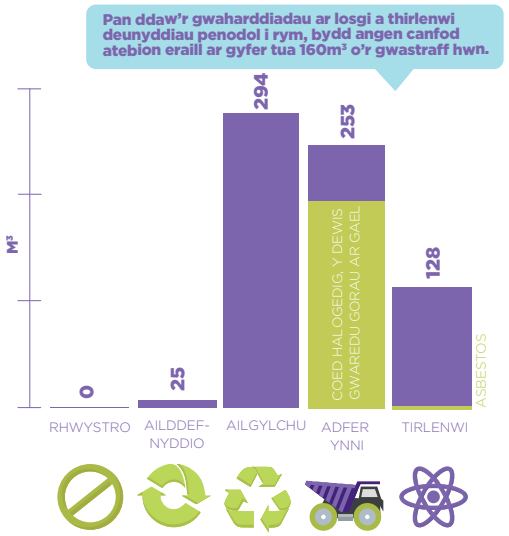
4.2.3 Anterth Medi
Y ffrwd wastraff a gynhyrchwyd fwyaf ym Medi oedd gwastraff adeiladu cymysg (25.7m^3) a brics (16.2m^3). Roedd hyn oherwydd gwaith dymchwel ychwanegol na chafodd ei ragweld yn unol â chyfarwyddyd y Cleient ym Medi 2014 a Thachwedd 2014.

4.2.4 Anterth Tachwedd a Rhagfyr
Cynyddodd maint y gwastraff adeiladu i'w anterth ym misoedd Tachwedd(47.7m^3) a Rhagfyr (29.3m^3). Awgryma'r ymweliadau safle a wnaed yn y cyfnod hwn mai'r rheswm dros y cynnydd yma mewn gwastraff cymysg oedd pwysau amser ar y safle oherwydd yr ymdrechion i orffen y prosiect a chlirio'r safle cyn ei drosglwyddo. Efallai fod y ffactorau hyn wedi cyfrannu at ostyngiad ym maint y gwastraff a wahanwyd ar y safle.

4.3 Dadansoddiad fesul opsiwn rheoli gwastraff

HIERARCHAETH WASTRAFF (GWASTRAFF A GRËWYD)

GWASTRAFF A GRËWYD (m³)



I gyrraedd y pwynt o gynhyrchu dim gwastraff, rhaid canolbwyntio ymdrechion ar lefelau uchaf yr hierarchiaeth wastraff er mwyn ceisio atal gwastraff rhag cael eu greu yn y lle cyntaf a lleihau i'r eithaf y gwastraff a gynhyrchir. Mae'r diagram uchod yn dangos dosbarthiad y gwastraff a grëwyd fesul math.

4.3.1 Atal

Yn y prosiect hwn, ni lwyddodd yr ymyriad Galluogi Dyfodol Diwastraff i rwystro gwastraff rhag cael ei gynhyrchu mewn meintiau mesuradwy. Fodd bynnag, dylid nodi fod mesurau syml fel defnyddio deunyddiau off-cut ar y safle wedi arwain at ostwng maint y gwastraff a gynhyrchwyd, er ei bod yn anodd mesur union faint y gostyngiad hwnnw. Fel rhan o'r ymarferiad BIM, y ceir ei fanylion yn adran 5.1, ailfodelwyd dyluniad yr adeilad (o fewn cyfyngiadau cynllunio) a gwelwyd fod posibilrwydd osgoi 80m³ o wastraff (yn seiliedig ar ostyngiad o 12.1% yn y deunyddiau angenrheidiol i adeiladu'r wal).

4.3.2 Ailddefnyddio

Drwy gydweithio â'r gadwyn gyflenwi, dychwelwyd chwech llond sgip o flociau Durisol dros ben a/neu flociau wedi eu difrodi i'w hailddefnyddio. Roedd hyn gyfwerth â 25m³ o ddeunyddiau a fyddai fel arall wedi cael eu hanfon i'w claddu mewn safle tirlenwi.

4.3.3 Ailgylchu

Cafodd pedwar deg dau y cant (294m³) o'r gwastraff a gynhyrchwyd yn ystod y prosiect ei ailgylchu. Ymhlith y cyfraddau ailgylchu uchaf yr oedd ailgylchu 100% o gardfwrdd, byrddau plastr a phlastig. Roedd y raddfa ailgylchu gwastraff anadweithiol gan y cwmni rheoli gwastraff yn 98%. Y cyfraddau ailgylchu isaf a gyflawnwyd oedd gwastraff cymysg a adroddwyd fel 60.3%. Tybir mai'r rheswm dros hyn oedd natur gymysg y gwastraff a roddwyd yn y sgipiau. Gallai hyn fod wedi arwain at groes-lygru ac at ddeunydd ailgylchu o ansawdd is o ganlyniad.

4.3.4 Adfer ynni

Gyrrwyd tri deg chwech y cant (253m³) o'r gwastraff i adfer ynni (energy recovery). Digwyddodd hyn oherwydd y foliwm uchel (209m³) o goed halogedig a gynhyrchwyd. Llosgi neu adfer ynni yw'r ffordd orau o drin y gwastraff yma ar hyn o bryd.

4.3.4 Tirlenwi

Gyrrwyd deunaw y cant (18%) o'r gwastraff i'w dirlenwi (128m³), y rhan fwyaf ohono yn wastraff cymysg. Roedd deuddeg metr giwbig (12m³) o'r cyfanswm a yrrwyd i'w dirlenwi yn asbestos - dyma'r unig ddewis economaidd ar gyfer y gwastraff hwn ar hyn o bryd. Roedd y ffigwr cymharol uchel (18%) a yrrwyd i'w dirlenwi i raddau helaeth oherwydd tân yn safle'r cwmni rheoli gwastraff a ddigwyddodd yn ystod y cyfnod adrodd yn ôl. Efffeithiodd y tân yn ddifrifol ar effeithlonrwydd gweithrediadau'r cwmni rheoli gwastraff a arweiniodd at anfon y maint o wastraff a nodir uchod i'w waredu trwy dirlenwi.

4.4 Dadansoddiad fesul ffrwd wastraff unigol

4.4.1 Coed

Creodd y pydredd sych a gwlyb annisgwyl o fewn yr adeilad sawl her i dîm y safle. Yn gyntaf, cynhyrchwyd mwy o wastraff coed na'r disgwyl . Hefyd, ar ddechrau'r prosiect roedd tîm y safle wedi rhagweld y byddent yn gadael y lloriau pren parquet gwreiddiol a distiau'r lloriau yn eu lle. Fodd bynnag, oherwydd y pydredd sych a gwlyb nid oedd hynny'n ymarferol. Atgyweiriwyd distiau a thrawstiau coed a'u hailddefnyddio ym mhob rhan o'r hen adeilad hyd y gellid. Fodd bynnag, ni chafodd y rhain eu cyfrif i wybod faint yn union a ailddefnyddiwyd. Nid oedd y nodiadau trosglwyddo gwastraff yn gwahaniaethu rhwng coed "glan" a choed pydredd sych. Rydym felly wedi amcangyfrif fod y mwyafrif o'r gwastraff hwn wedi ei yrru i adfer ynni yn hytrach na'i droi'n sglodion a'i wasgaru dan anifeiliaid, sef y gyrchfan arall a enwyd ar gyfer gwastraff coed.

Roedd gan dîm y prosiect darged dechreuol o ddeg sgip o goed ond adroddwyd fod y ffigwr ar ddiwedd y prosiect yn dri deg tri o sgipiau. Roedd y gwahaniaeth rhwng y targed a'r deilliant i'w briodoli'n llwyr i faint y pydredd sych a gwlyb annisgwyl a gafwyd.

4.4.2 Brics

Cynhyrchwyd 24m^3 o wastraff brics oherwydd yr angen i ddymchwel wal yr hen ysgol. Aed â'r gwastraff brics at Atlantic and Neal Soil Supplies lle cawsant eu malurio'n fân i'w hailddefnyddio fel agreg.

4.4.3 Blociau Durisol

Defnyddiodd y prosiect flociau Durisol i godi'r adeilad newydd. Cynhyrchir y blociau hyn o sglodion coed wedi eu hasio ynghyd gyda sment. Unwaith y maent ar y safle, cânt eu bondio yn eu lle gydag ewyn polystyrene a growt seiliedig ar sment. Dewiswyd y cynnyrch hwn gan y cleient er mwyn helpu i gyrraedd y nod o sicrhau fod 10% o gynnwys y cynllun wedi ei ailgylchu. Mae hyn, fodd bynnag, wedi amlygu'r potensial am rai anawsterau yn y dyfodol. Wrth edrych ar y fethodoleg ar gyfer defnyddio'r blociau yma ar y prosiect hwn, daethom i'r casgliad mai'r unig ffordd o'u gwaredu ar ddiwedd eu hoes fyddai trwy eu tirlenwi. Oherwydd ymgorffori dur atgyfnerthu, polystyrene a growt sment fel llenwad a defnyddio ewyn ehangedig (expaned foam) i lenwi foidiau, byddai gwahanu'r deunyddiau hyn oddi wrth y blociau yn y dyfodol yn bur anymarferol. Cytunwyd ar drefniad "cymryd yn ôl" gyda Durisol lle byddent yn derbyn yn ôl i'w stoc unrhyw flociau na chafodd eu defnyddio ac y byddai blociau wedi torri yn mynd nôl i'r broses gynhyrchu a'u hail ddefnyddio i wneud ffurfiau wal. Sicrhaodd y trefniant hwn na chafodd unrhyw flociau Durisol dros ben neu flociau wedi torri eu hanfon i'w tirlenwi gan arbed cost o tua £360.

4.4.4 Byrddau Plastr

Cynhyrchwyd mwy o wastraff byrddau plastr (18.3m^3) nag a ragwelwyd (8m^3). Y bwriad gwreiddiol oedd atgyweirio a sgimio dros y byrddau plastr oedd eisoes yn eu lle ond unwaith y canfuwyd pydredd sych, roedd yn rhaid symud ymaith y plastr i gael gwared o'r coed oedd wedi eu suddo yn y gwaith brics. Cynhyrchwyd 18.3m^3 o wastraff byrddau plastr a chredwn fod y cyfan wedi ei ailgylchu.

4.4.5 Asbestos

Ddarganfuwyd Asbestos yn ystod y dymchwel ac adnewyddu'r adeilad. Anfonodd 12.7m3 o wastraff i'r safle tirlenwi peryglus. Mae tirleni yn ystyriodol am y ffordd fwya' economaidd ar hyn o brid.

4.4.6 Mixed construction waste

Barnwyd fod y mwyafrif o'r sgipiau a adawodd y safle yn wastraff cyffredinol cymysg a methodd tîm y prosiect â chyrraedd y targed o 35 sgip. Ar ddiwedd y prosiect roedd 102 o sgipiau gwastraff cyffredinol cymysg wedi gadael y safle. Rydym o'r farn fod nifer o ffactorau gwahanol yn gyfrifol am y gwahaniaeth rhwng yr amcangyfrif dechreuol a'r ffigwr terfynol. Ar ddechrau'r prosiect, roedd y safle wedi darparu sgipiau gwahanol ar gyfer gwastraff anadweithiol, coed a chymysg. Fodd bynnag, wrth i'r cynllun fynd yn ei flaen, oherwydd pwysau gorffen mewn pryd a newidiadau yn staff y safle dechreuodd sgipiau gael eu halogi gan ddeunydd cymysg. O ganlyniad bu'n rhaid cael gwared o'r gwastraff fel gwastraff cymysg cyffredinol am gost uwch. Erbyn diwedd y prosiect, roedd hefyd symiau mawr o wastraff cardfwrdd yn cael ei roi yn y sgipiau yn hytrach nag mewn sgip ar wahân. Oherwydd y ffactorau hyn roedd y gost o waredu gwastraff yn uwch nag y dylai fod.

Gyrrwyd gwastraff adeiladu cymysg at Atlantic i'w brosesu a'i ddidoli. Yn ystod y cyfnod adrodd deëllir fod tua 60% o'r gwastraff hwn wedi cael ei ailgylchu, 11% wedi ei anfon i'w drylosgi a'r 29% arall ei yrru i safle tirlenwi. Roedd y raddfa gwaredu trwy dirlenwi gan y cwmni rheoli gwastraff yn llawer uwch na'u patrwm arferol oherwydd tân difrifol a gafwyd yn 2014 a effeithiodd yn negyddol ar effeithlonrwydd y cyfleusterau adfer. Mae'n bosibl hefyd i'r raddfa ailgylchu ar gyfer gwastraff adeiladu cymysg ddeillio o natur gymysg y gwastraff lle cafodd deunydd ei halogi ac, o ganlyniad, ei ystyried yn ddeunydd ailgylchu o safon is.

4.5 Dadansoddiad yn ôl cost

Cyfanswm cost gwaredu gwastraff y prosiect oedd £21,340. Arbedwyd £360 gan drefniant cymryd yn ôl y blociau Durisol. Byddai'r gost o waredu gwastraff wedi bod yn llai pe na bai cymaint o sgipiau wedi cael eu categoreiddio'n "wastraff cymysg". Yn draddodiadol, codir mwy am waredu sgipiau gwastraff cymysg na sgipiau sy'n cynnwys un math o wastraff. Gallai didoli a gwahanu gwastraff yn well ar y dechrau fod wedi arbed llawer o arian. Er enghraifft, pe byddid wedi cyrraedd targed gwreiddiol WRW o 35 o sgipiau gwastraff yn hytrach na'r 102 a gafwyd mewn gwirionedd, a bod y gweddill wedi cael eu gwaredu yn ôl y pris am ddeunydd a wahanwyd, byddid wedi arbed £1,340 ar gostau sgip. Nid yw'r pris a dalwyd am waredu holl wastraff cynllun Millbank ond yn cyfateb i 0.7% o gost gyfalaf y cynllun. Fodd bynnag, mae gwario £20,000 ar waredu gwastraff yn swm sylweddol y gellid bod wedi ei leihau. I gwmnïau adeiladu sy'n gweithio ar gynlluniau niferus bob blwyddyn, y mae'n bosibl iddynt arbed llawer iawn o arian yn flynyddol.

4.6 Dadansoddiad fesul meincnod diwydiant

Cymharwyd y gwastraff a grëwyd ym Millbank gyda'r cyfartaledd m^3 o wastraff a gynhyrchwyd mewn prosiectau eraill yn seiliedig ar eu harwynebedd a'u cost gyfalaf.

Gwastraff Millbank	Data SMARTWaste ar gyfer Cymru (Codi adeiladau Addysg newydd)	Data SMARTWaste ar gyfer Cymru (Adnewyddu adeiladau Addysg)	Credydau BREEAM (Y gwastraff a gynhyrchir am bob 100m^2 o arwynebedd llawr gros)	
52.8m^3/m^2	17.5m^3/m^2 yn seiliedig ar 30 prosiect	22.3m^3/100m^2 yn seiliedig ar 5 prosiect	1 credyd <13.3m^3	3 credits <3.4m^3
30.4m^3/£100k	10.3m^3/£100k yn seiliedig ar 31 prosiect	12.9m^3/£100k yn seiliedig ar 6 prosiect	2 gredyd <7.5m^3	Enghreifftiol <1.6m^3

Defnyddiodd CEW data o "BRE's SMARTWaste system" ar gwastraff adeiladwaith yn cynhyrchi o prosiectau yng Nghymru a wnaeth cwbwlhau yn y diwedd o Mehefin 2013. SMARTWaste yw system cofnodi ar y we sydd yn helpu tracio, rheoli a cofnodi ar effaithion amgylcheddol a cynaliadwedd yn cynnwys rheoli gwastraff.

Mea'r BREEAM (BRE Environmental Assesment Method) yn ceal ei defnydd yn eang am asesiad amgylchedd i adeiladau a cyminedau. Mae BREEAM yn cyfeirio materion amgylcheddol a cynaliadwedd, ac yn defnuddio credydd yn yr asesiad cymhwysedd.

Bernir mai'r symiau annisgwyl o goed pydredd sych a phydredd gwlyb oedd y ffactor oedd fwyaf tebygol o fod wedi dylanwadu ar ganlyniad cyflawniad ar ddangos o Millbank.

5.0 Modelu Gwybodaeth Adeiladu (BIM)

Fel rhan o'r broses Galluogi Dyfodol Diwastraff comisiynwyd Gillard Associates Ltd i baratoi model BIM i hysbysu ac addysgu'r pawb a fyddai'n cyfrannu at reoli gwastraff, naill ai drwy helpu i wneud penderfyniadau ar y safle neu trwy edrych ar senarios rhithiol ar gyfer y cyfnod wedi cwblhau'r adeilad. Am fod diffygion na chafodd eu rhagweld yn ffabrig yr hen adeilad wedi cael effaith ddrwg ar gynllun Ysgol Millbank cywasgwyd amserlen y prosiect yn ddirfawr. Roedd hwn yn ffactor arwyddocaol a rwystrodd ddefnyddio neu gymharu â'r model BIM yn ystod y cyfnod adeiladu. O ganlyniad, canolbwyntiwyd y defnydd o BIM ar ddeilliannau rhithiol a damcaniaethol wedi i'r gwaith ddod i ben.

5.1 Gwella prosesau

Cydnabyddir yn eang yn y sector amgylcheddau adeiledig fod troi darluniau dau ddimensiwn ar sgrîn neu bapur yn adeiladau tri dimensiwn go iawn yn aml yn arwain at wrthdrawiadau na chafodd eu rhagweld, yn arbennig mewn perthynas â phwyntiau cyswllt cymhleth a gwasanaethau mecanyddol a thrydanol. Fel sy'n digwydd yn gyffredinol, cafodd y gwrthdrawiadau ym Millbank eu datrys drwy adweithio yn hytrach na rhagweithio i'r broblem ar y safle, a hynny'n aml yn cael effaith negyddol ar y defnydd o adnoddau materol ac amser.

Yn yr adolygiad a gynhaliwyd ar ôl cwblhau contract y prosiect, roedd yn eglur mai'r gwrthdrawiadau a gafodd eu hadnabod gan y tîm BIM (heblaw'r diffygion a ddaeth i'r amlwg yn yr hen adeilad) oedd prif achosion yr anawsterau a gafwyd yn y cyfnod adeiladu. Mae'n hawdd bod yn ddoeth wrth edrych yn ôl, ond mae hefyd yn wir dweud y gallai'r model BIM fod wedi gwneud cyfraniad gwerthfawr at y broses dylunio manwl trwy alluogi archwilio mewn ffordd rithiol y materion a gafodd eu hadnabod yn yr adroddiad blaenorol.

Cynhaliwyd gweithdy BIM gyda thîm y safle a'r cleient i edrych ar newidiadau damcaniaethol i ddyluniad a deunyddiau'r adeilad. Arweiniodd hyn at ymchwilio beth fyddai deilliannau dyluniad gwahanol ar gyfer estyniad newydd yr ysgol a chymharu hynny â'r dyluniad a ddefnyddiwyd go iawn. Y rhesymeg tu cefn i'r ymarferiad oedd cael perfformiad ynni gwell drwy leihau "amlen" allanol yr adeilad (cau'r mannau agored rhwng yr estyniad arfaethedig a'r adeilad oedd yno eisoes).

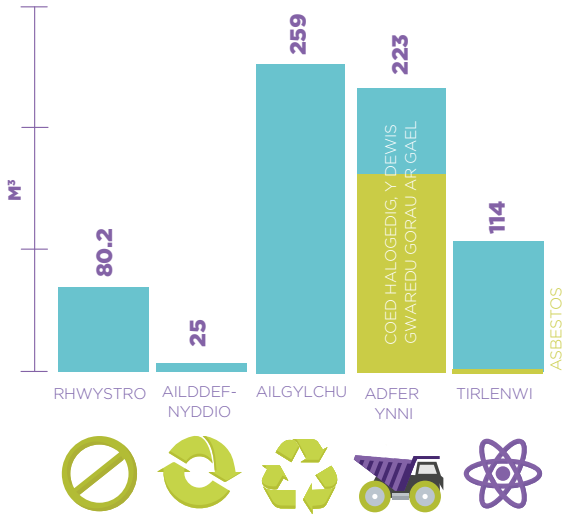
Yn y gweithdy BIM barnwyd fod maint y gegin yn rhy fawr ar gyfer ysgol o'r math yma. Gostyngwyd 20% ar ei maint cyfan.

Edrychwyd ar y perfformiad ynni hefyd drwy leihau amlen allanol yr adeilad (cau'r mannau agored rhwng yr estyniad arfaethedig a'r adeilad oedd yno eisoes). Arweiniodd y newid hwn at ostyngiad o 13.06% mewn allyriadau CO_2 . Hefyd byddid wedi lleihau foliwm y waliau oedd angen eu codi o 328.11m^3 (y gwir ffigwr) i 287.89m^3 - gostyngiad 12.1% a fyddai wedi arwain at arbed adnoddau. Ar y llaw arall, byddai arwynebedd y to, y lloriau a'r ffenestri wedi cynyddu rhwng 0.8 a 5.8%.

Yr hyn a adeiladwyd

Model arall posibl

CYNHYRCHION GWASTRAFF (m^3) GYDA CYMHWYSO BIM YMARFER



6.0 Edrych tua'r dyfodol - Cymhwyso'r Bil Amgylchedd

Amlygodd y prosiect hefyd rai heriau posibl yn y dyfodol i'r diwydiant adeiladu o ran gwaredu gwastraff. Mae gwaharddiad ar fin cael ei gyflwyno fel rhan o'r Bil Amgylchedd a fydd yn atal llosgi a thirlenwi coed, papur, cardfwrdd, gwydr, plastig, mhetalau a gwastraff bwyd. O gymhwyso hyn i'r gwastraff a grëwyd gan brosiect Ysgol Gynradd Millbank byddai'n rhaid bod wedi canfod ateb gwahanol ar gyfer tua 160m^3 o ddeunyddiau - yn bennaf gwastraff cymysg a oedd yn cynnwys papur, blychau cardfwrdd a gwastraff anadweithiol a yrrwyd i ganolfan adfer ynni neu i'w dirlenwi. Mae angen cynnal ymchwil er mwyn deall y dewisiadau posibl yn well ac adnabod y seilwaith priodol a angenrheidiol i gwrdd â gofynion y ddeddfwriaeth newydd.

7.0 Heriau allweddol

7.1 Pethau na ellid eu rhagweld

Unwaith y dechreuodd y prosiect, canfuwyd pydredd sych a gwlyb yn yr hen adeilad nad oedd yn hysbys cyn i'r gwaith ddechrau. Arweiniodd hyn at greu rhagor o wastraff oherwydd yr angen i gael gwared o'r coed halogedig a hefyd yr angen i symud ymaith y plastr, lloriau a nenfydau cysylltiedig.

7.2 Amser

Crëwyd heriau amser i'r timau oedd yn gweithio ar y safle o ganlyniad i ddefnyddio cynhyrchion newydd a gweithio i amserlen mor dynn. Golygodd hyn o bosibl na fedrodd tîm y safle ganolbwyntio cymaint ag arfer ar brosesau rheoli gwastraff.

7.3 Cynhyrchion

Er y dewiswyd blociau Durisol oherwydd eu lefel uchel o gynnwys wedi ei ailgylchu, mae'r casgliadau a nodwn yn 4.4.3. uchod wedi ein darbwyllo y dylid ystyried yn ofalus y dull adeiladu a fabwysiedir wrth ddefnyddio'r blociau hyn mewn ffurfwaith parhaol yng nghynlluniau'r dyfodol. Os na wneir hynny, mae'n bosibl y cyfyd problemau gwaredu pan gaiff yr adeilad ei ddatgymalu.

7.4 Data

Cynhaliwyd yr arolwg o gyflwr yr hen adeilad cyn gosod contract yn ystod y tymor ysgol. Felly roedd presenoldeb staff a disgyblion yn cyfyngu'n arw ar y gallu i gael mynediad i bob rhan o'r adeilad. Cyfyngwyd ar hyd a lled yr arolwg ac o ganlyniad cododd nifer o faterion na chafodd eu rhagweld, megis y pydredd sych a gwlyb na ddaeth i'r amlwg nes dechrau'r gwaith adeiladu. Roedd yr effaith ar y rhaglen adeiladu, ac ar y gwastraff a gynhyrchwyd a chyfanswm cost y prosiect yn sylweddol iawn.

Hefyd, cafodd y tan yn y ganolfan rheoli gwastraff effaith arwyddocaol ar y gwastraff a adferwyd o'r prosiect. Yn hanesyddol bu cyfradd adfer rhag tirlenwi'r ganolfan hon yn fwy na 90%. Fodd bynnag, difrodwyd y cyfleuster ailgylchu deunyddiau (MRF) yn arw gan leihau'n ddifrifol allu'r cwmni i ailgylchu deunyddiau. Mae'r effaith ar y deilliannau i'w weld yn y ffigyrau.

7.5 Ymddygiad

Heb os, arweiniodd newidiadau yn staff a rheolaeth y safle at anghysonderau yn yr arferion rheoli gwastraff. Hefyd, cyflwynwyd heriau gan y staff asiantaeth a benodwyd i'r prosiect o ran eu hymrwymiad i'r ymgyrch Galluogi Dyfodol Diwastraff ac arferion WRW eu hunain.

Oherwydd cyfyngiadau'r safle, agweddau logisteg heriol ac amserlenni'r prosiect, llithrodd arferion rheoli gwastraff i fod yn ystyriaeth eilradd. Yn absenoldeb gofyniad BREEAM a chymhellion i leihau gwastraff, roedd diffyg ymwybyddiaeth a ffocws ar faterion gwastraff ar y safle gan mai cyfyngedig oedd y trafodaethau cyn-gosod a'r trefniadau ymsefydlu (induction) ar y safle. Hefyd roedd diffyg arwyddion clir ar y sgipiau. Nid oedd ffocws ddigon cryf ar wastraff yn y cyfarfodydd cyn-gosod ac, oherwydd halogi sgipiau oedd i fod i gynnwys un math o ddeunydd yn unig, llenwyd rhagor o sgipiau gwastraff cymysg nag a fwriadwyd.

8.0 Llwyddiannau

8.1 Deunyddiau dros ben

Cafodd deunyddiau dros ben, megis paent, teils llawr a ffenestri eu cadw mewn ardal storio fel y gall yr ysgol eu defnyddio i wneud gwaith cymhennu ac atgyweirio yn ôl yr angen yn y dyfodol.

8.2 Arferion safle

Roedd y gwaith cynllunio a pharatoi ar ddechrau'r prosiect ar gyfer gwahanu a rheoli gwastraff y safle yn effeithiol.

8.3 Y gadwyn gyflenwi

Daethpwyd i drefniant "cymryd yn ôl" gyda Durisol fel eu bod yn derbyn unrhyw flociau na chafodd eu defnyddio yn ôl i'w stoc ac fel y byddai unrhyw flociau wedi torri yn mynd nôl i'r broses gynhyrchu i'w hailddefnyddio i wneud ffurfiau wal. Sicrhaodd y trefniant hwn na fyddai blociau Durisol dros ben neu wedi torri yn cael eu gwaredu mewn safle tirlenwi, ac arbedodd y trefniant £360.

8.4 Ymgysylltu â'r gymuned

Gweithiodd WRW yn agos iawn gyda'r ysgol a'r gymuned leol fel eu bod yn cyfrannu at y drafodaeth ac yn ymwybodol o effeithiau amgylcheddol y gwaith adeiladu.

8.5 Targedau Llywodraeth Cymru

Llwyddodd y prosiect i gwrdd â tharged 2015/16 Llywodraeth Cymru ar gyfer paratoi o leiaf 70% o bob gwastraff ar gyfer ei ailddefnyddio, ailgylchu neu adfer.

8.6 Post project follow up

O ganlyniad uniongyrchol i ymwneud WRW â'r prosiect Galluogi Dyfodol Diwastraff, mae'r cwmni bellach wedi cyflwyno'r newidiadau canlynol ar gyfer pob un o'u prosiectau yn y dyfodol:

1. Mae gwastraff bellach ar agenda'r cyfarfodydd cyn-gosod a gynhelir gyda phob is-gontractwr. Cytunir ar strategaethau lleihau gwastraff a chytunir ar y meintiau disgwyliedig ymhell cyn dechrau'r gwaith.
2. Defnyddir SMARTWaste fel dogfen fyw trwy gydol prosiectau gan ddiweddaru'r wybodaeth yn rheolaidd. Defnyddir y data mewn cyfarfodydd prosiect misol.
3. Gyrrwyd data gwastraff cywirach at y tîm amcangyfrif er mwyn datblygu gwell dealltwriaeth ar gyfer tendrau tebyg yn y dyfodol.
4. Caiff amcangyfrifon gwastraff eu cyfathrebu'n gliriach i dimau safle mewn ymgais i annog rheoli gwastraff yn barhaus trwy gydol y prosiect. Mae lleihau gwastraff hefyd ar agenda cyfarfodydd dechrau prosiect er mwyn adnabod meysydd lle gellir gostwng y gwastraff a gynhyrchir.

9.0 Casgliadau ac argymhellion

9.1 Casgliadau

Rhaid canmol tîm WRW am eu cyfraniadau agored a di-flewyn-ar-dafod wrth gymryd rhan yn Galluogi Dyfodol Diwastraff. Roedd heriau gwirioneddol mewn rhai agweddau o'r prosiect ac fe'u rhannwyd yn agored gan y rheolwyr a'r timau safle.

Ni lwyddwyd i yrru dim gwastraff o gwbl i'w dirlenwi. Fodd bynnag, gwir werth Galluogi Dyfodol Diwastraff oedd ennill gwell dealltwriaeth o gymhlethdodau prosesau adeiladu, eu cydberthynas a'r effaith ar faint y gwastraff a gynhyrchir.

Amlygodd profiad Ysgol Gynradd Millbank yr elfennau canlynol, a restrir yn nhrefn eu dylanwad, a gyfrannodd oll tuag at fethu â gwireddu'r dyhead i alluogi dyfodol cwbl ddiwastraff:

1. Pethau na ellid eu rhagweld
2. Amser
3. Dyluniad
4. Deunyddiau

Wrth i'r prosiect ddatblygu cafwyd cyfres o heriau annisgwyl. Arweiniodd y pydredd sych a gwlyb at gynhyrchu tua 200m^3 o goed halogedig, na chynlluniwyd ar ei gyfer. Roedd hyn bron 30% o gyfanswm y gwastraff a gynhyrchwyd. Hefyd cynhyrchwyd mwy o wastraff byrddau plastr na'r disgwyl gan mai'r bwriad gwreiddiol oedd trwsio a sgimio dros yr hen blastr. Ond unwaith y cafwyd hyd i bydredd sych, roedd yn rhaid cael gwared o'r plastr er mwyn cael at y pren pydredig oedd wedi ei suddo yn y gwaith brics. Yn ogystal â'r effaith ar y rhagolygon cynhyrchu gwastraff a'r gofynion rheoli, ychwanegodd hyn yn sylweddol at yr amser a gymerwyd i gwblhau'r prosiect.

Gosodwyd y contract gwreiddiol gyda'r bwriad o weithredu dros gyfnod byr iawn rhwng Ionawr 2014 a Medi 2014. Oherwydd y pwysau amser a wynebir yn aml gan dimau safle, yn anffodus gyrrwyd materion gwastraff i waelod y rhestr o flaenoriaethau dyddiol. Yn achos Millbank, mae'n debygol fod y pwysau hwn yn ffactor a gyfrannodd at natur cymysg yn bennaf y gwastraff a waredwyd o'r safle. Mea'r rhaglen seiliedig ar amswer yn beirniadol i llwyddiant deilliannau o ansawdd uchel.

Gall y dyluniad gael dylanwad arwyddocaol y gwastraff a gynhyrchir. Yn achos Millbank, bernir fod dyluniad yr adeilad wedi cynyddu maint y gwastraff a gynhyrchwyd a'r deunyddiau angenrheidiol. Fel y trafodwyd yn yr adroddiad hwn, drwy ddefnyddio BIM i leihau amlen allanol yr adeilad fe ellid bod wedi lleihau maint y deunyddiau a'r gwastraff cysylltiedig. Hefyd, oni bai am yr angen i wynebu pethau annisgwyl, byddai mwy o amser wedi bod ar gael i dîm y safle ddefnyddio'r model BIM yn llawn yn ystod y cyfnod adeiladu. O wneud hynny byddent wedi medru datrys gwrthdrawiadau ymlaen llaw, cyn iddynt ddigwydd ar y safle ei hun, gan arbed adnoddau ac amser.

Nid yw defnyddio cynhyrchion cynaliadwy bob amser yn rhoi sylw i'r oblygiadau gwaredu ar ddiwedd oes y cynhyrchion hynny. Mewn rhai enghreifftiau, gall y dulliau a ddefnyddir i fodloni gofynion cynaliadwyedd gael sgil effeithiau negyddol neu ni chânt eu defnyddio i'w llawn botensial.

9.2 Argymhellion i'r contractwr

Mae'n allweddol bwysig fod y person cyfrifol am gynhyrchu'r amcangyfrif gwastraff yn cadw mewn cysylltiad rheolaidd â thîm y safle fel bod y rhagolygon yn rhesymol, yn gyraeddadwy ac yn seiliedig ar ddata a gasglwyd o berfformiadau'r gorffennol. Mae hefyd yn bwysig fod y person hwnnw yn rhannu'r arferion gorau a chynnig adborth ynghylch perfformiad. Yn ei hanfod, rhaid i aelod o dîm y safle gymryd meddiant o reolaeth gwastraff.

Dylid ailddiffinio'r gweithdrefnau a ddefnyddir gan gwmnïau i baratoi rhagolygon gwastraff, casglu a storio data am wastraff, rheoli'r gwastraff a gynhyrchir ar safle a'r gofynion adrodd. Hefyd dylai archwilwyr mewnol edrych yn rheolaidd ar weithgareddau cwmnïau er mwyn sicrhau fod eu gweithdrefnau a phrosesau'n gweithio.

Mae didoli a gwahanu gwastraff yn ei ffynhonnell yn bwysig os am gynyddu'r canran o wastraff sy'n cael ei adfer. Bydd y cwmni mwyaf blaengar yn y maes rheoli gwastraff yn ei chael yn anodd adfer mwy na 90% (a fydd yn ofynnol erbyn 2019/20) ar gyfer gwastraff cymysg. Bydd hyn hefyd yn dod yn fater mwy dyrys fyth pan gyflwynir Bil yr Amgylchedd (Cymru) yn

gosod dyletswydd ar gynhyrchwyr gwastraff i wahanu'r gwastraff canlynol yn ei darddle: papur, cardfwrdd, gwydr, metal, plastig, coed a gwastraff bwyd. Rhaid trafod y gofynion hyn yn ystod cyfarfodydd cyn-gosod fel bod pawb yn gwybod beth yw eu cyfrifoldebau a bod gwastraff yn cael ei amlygu fel blaenoriaeth. Dylid cytuno ar y gofynion gwastraff a'r mecanweithiau adrodd gyda'r cwmni rheoli gwastraff a ddewiswyd er mwyn iddynt fod yn ymwybodol o anghenion adrodd y prosiect a thrafod y cyfleoedd ar gyfer rheoli gwastraff.

Yn ystod sesiynau ymsefydlu ar safle (site inductions) dylid cael ffocws ar wastraff fel bod pob aelod o staff yn ymwybodol o'r disgwyliadau arnynt mewn perthynas â rheoli gwastraff. I alluogi hyn dylid datblygu "sgyrsiau bocs tŵls" a'u cynnal gyda phob aelod o dîm y safle. Dylid cynnal sesiynau codi ymwybyddiaeth ymhlith holl staff y cwmni yn amlinellu pwysigrwydd delio â materion gwastraff, a'r costau cysylltiedig.

Mae gan Modelu Gwybodaeth Adeiladu (BIM) y potensial i greu manteision arwyddocaol a gellir ei ddefnyddio i helpu'r gwaith o adnabod gwrthdrawiadau a chyfleoedd i leihau gwastraff i'r eithaf (trwy ddefnyddio meintiau safonol ar gyfer brics, blociau a byrddau plastr), symleiddio'r broses adeiladu a sicrhau fod unrhyw broblemau'n cael eu datrys cyn dechrau gweithio ar y safle.

Dylid cynnal trafodaethau cynnar gyda'r tîm dylunio a/neu'r cleient i ganfod a yw cynllun wedi ei ddylunio neu beidio gan ddefnyddio meintiau safonol er mwyn arbed creu gwastraff. Os nad ydyw, dylid ystyried a oes cyfle i wneud hynny gan bwysleisio'r manteision o ran arbed amser, adnoddau a chostau. Cyn dod i gytundeb gyda chyflenwyr, dylid trafod y posibilrwydd o sefydlu cynlluniau "cymryd yn ôl" ar gyfer deunyddiau dros ben, deunydd pacio, off cuts a nwyddau wedi eu difrodi.

Os oes gwaith dymchwel i ddigwydd, dylid cynnal arolwg cyn-dymchwel i adnabod cyfleoedd ailddefnyddio ac ailgylchu.

9.3 Argymhellion i'r cleient

Nid yw defnyddio cynhyrchion cynaliadwy bob amser yn rhoi sylw i'r oblygiadau gwaredu ar ddiwedd oes y cynhyrchion hynny. Dylid bwrw ati i greu rhestr o gynhyrchion cynaliadwy gan ddadansoddi eu cylch bywyd llawn er mwyn sicrhau y rhoddir sylw i anawsterau posibl yn y dyfodol yn gysylltiedig â'r cynhyrchion hynny.

Gall penderfyniadau amseru a rhaglennu ddylanwadu'n sylweddol ar brosiect. Dylid pennu amserau "arwain i mewn" digonol fel bod digon o amser i gontractwyr roi pethau ar waith unwaith y dyfernir contract iddynt. Mae diffinio'r amserau arwain i mewn yn galluogi'r holl dimau safle, dylunio a chleient ddod at ei gilydd yn gynnar i drafod y prosiect. Gall cyfarfodydd fel hyn fod yn amhrisiadwy yn lleihau gwastraff, gwella cyfathrebu a datblygu trefniadau effeithlon ar gyfer y safle.

Mae angen adolygu'r targedau ar gyfer defnyddio deunydd wedi ei ailgylchu mewn prosiectau gan ystyried ai dyma'r ffordd fwyaf priodol o wneud cynllun yn fwy cynaliadwy. Mewn rhai achosion, gall y dulliau a ddefnyddir i fodloni'r gofynion hyn yn eu tro gael sgil effeithiau negyddol neu ni chânt eu defnyddio i'w llawn botensial.

Mae angen cynnal ymchwil i asesu priodoldeb y trefniadau presennol ar gyfer delio â gwastraff y gwaherddir ei dirlenwi a'i losgi cyn bo hir. Os nad oes atebion ar gael, rhaid eu canfod.

Mae canfyddiadau allweddol yr ymgyrch Galluogi Dyfodol Diwastraff a phrofiadau eraill yn dangos y gall prosiectau gyflawni graddfeydd ailgylchu ac adfer uchel dros ben (gan gyrraedd targedau Llywodraeth Cymru ar gyfer y diwydiant). Fodd bynnag gall hyn fod yn unig oherwydd effeithlonrwydd y cwmni rheoli gwastraff a ddefnyddiwyd yn hytrach nag unrhyw arferion ar y safle ei hun. Wrth fonitro a rheoli gwastraff fel rhan o brosiect, rydym angen canolbwyntio mwy ar faint o wastraff a gynhyrchwyd ac a rwystrwyd nag ar faint o wastraff a arbedwyd rhag cael ei ddanfon i safle tirlenwi.

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